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Sea level rise or shallow-water midden deposition? Archaeopedology at the Seminole Rest archaeological site, coastal East-Central Florida

Sylvia Scudder*

Environmental Archaeology Program, Florida Museum of Natural History, PO Box 117800, Gainesville, FL 32611 7800, USA

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Abstract

Sedimentological and faunal studies at the Seminole Rest archaeological site on the Atlantic coast of Volusia County, FL, addressed the question of whether construction of the large shell mound at the site began on dry land or in the shallow waters of Mosquito Lagoon. Particle-size analysis defined a sand body beneath the hardshell clam mound, which is bordered by mucky tidal marsh and the shallow, silty lagoon. Weathered kaolinite, hydroxy-interlayer vermiculite, and gibbsite clays in the sub-mound sediments, identified by X-ray diffraction, contrasted with the 'shrink-swell' smectite clays of the tidal marsh and mound periphery and corroborated the particle-size evidence of a sand bar or bank. The presence in the sub-mound sediments of articulated valves of the diminutive Brown Gem Clam (*Parastarte triquetra*, Family Veneridae), and their absence in the silty marsh sediments, presented another line of evidence for a sand body beneath the mound. *Parastarte* is a common inhabitant of shallowly submerged sand bars. The existence of articulated valves of all size classes below the mound argues for a thriving population of the clams in their preferred habitat at the onset of mound deposition, which would have begun in the shallow water adjacent to the shore and not on dry land.

Keywords: Archaeopedology; Sedimentology; Sea level; Depositional environment

1. Site characteristics and purpose of study

The Seminole Rest archaeological site in Volusia County, FL, consists of two aboriginal shell mounds on the western shore of Mosquito Lagoon on Florida's central Atlantic coast (Fig. 1). Snyder's Mound, comprised mainly of hardshell clam shells (*Mercenaria* spp.), is approximately 200 m long, 80 m wide, and presently 6.4 m high. Fiddle Crab Mound is a much smaller clam-shell-capped sand mound approximately 3 m in circumference and 1 m high. Twelve radiocarbon dates from selected levels in Snyder's Mound identify an 830 year period of construction and use from A.D. 590 to A.D. 1420 [8]. Fiddle Crab Mound was constructed and abandoned somewhat earlier: A.D. 120 to A.D. 1040. Because of the diminutive size of Fiddle Crab Mound, this study focused on the much larger footprint of Snyder's Mound to address the questions posed.

The base of Snyder's Mound is now shallowly submerged beneath the waters of Mosquito Lagoon, which prompted the question of its relationship to sea level: was the mound constructed on dry land and subsequently partially inundated, or was mound building begun by throwing emptied clam shells into shallow water adjacent to a living area or shellfish-processing site? This study addresses these questions by characterizing the original substrate now buried under a small mountain of shell. Sub-mound and local sediments are examined by grain-size analysis, X-ray identification of clays, and identification of macroscopic invertebrate infauna.

* Corresponding author. Tel.: +1-352-392-1721; fax: +1-352-392-3698.
E-mail address: scudder@flmnh.ufl.edu (S. Scudder).

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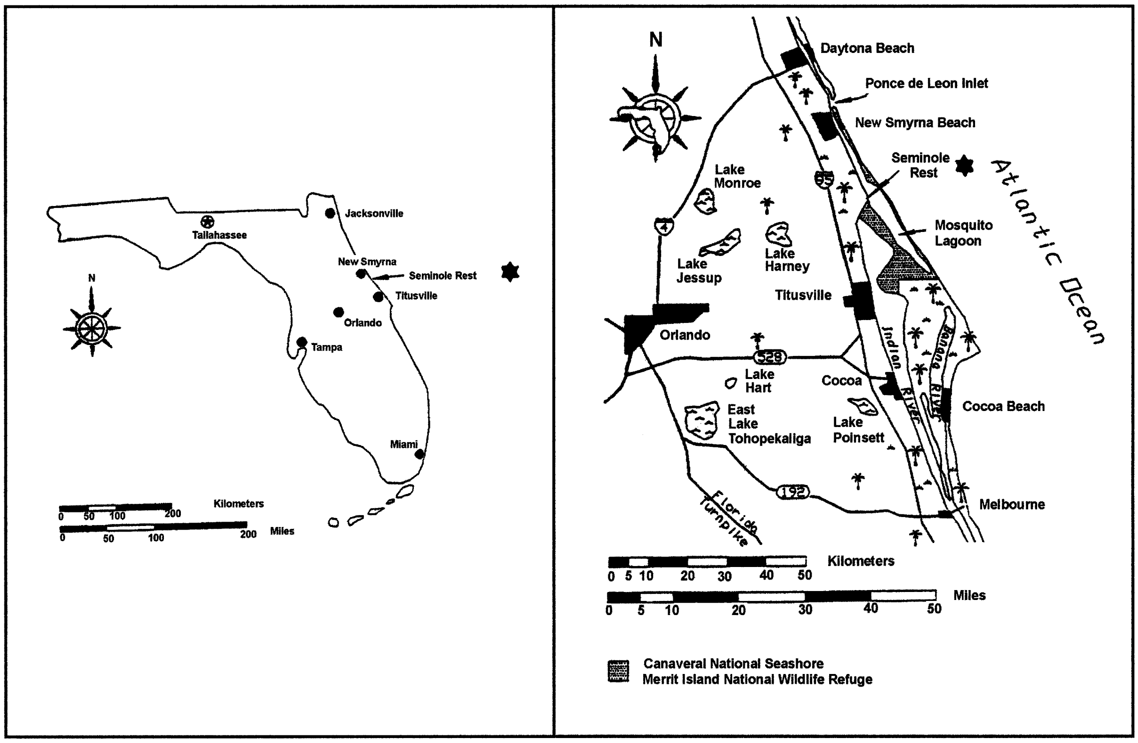

Fig. 1. Seminole Rest site locator maps.

2. Field sampling

Two types of samples were used for soil and sediment analyses: mechanically extracted cores from Snyder's Mound and hand-augered samples taken from the periphery of the mound and from the adjacent marsh. Fig. 2 locates core and auger sample placement on the mound and mound apron. Coring was done by geochemical engineers subcontracted by the National Park Service using a split-spoon, 1.5-in core which extracted 46-cm core increments. Placement of the cores at strategic points on the top and sides of the mound was directed by archaeologists. The cores penetrated the dense shell layers and terminated in the sand substrate directly below, thus recovering only the first 46 cm of sediment underlying the mound.

Thirteen sets of hand-augered samples were taken along the east and west margins of Snyder's Mound, through and adjacent to Fiddle Crab Mound, and in marsh areas south and southwest of the excavation units. On the west side of the site, samples were obtained on both sides of a modern canal, dredged parallel to the long axis of Snyder's Mound. Auger samples were taken in 10-cm increments and varied in total depth from 75 to 140 cm.

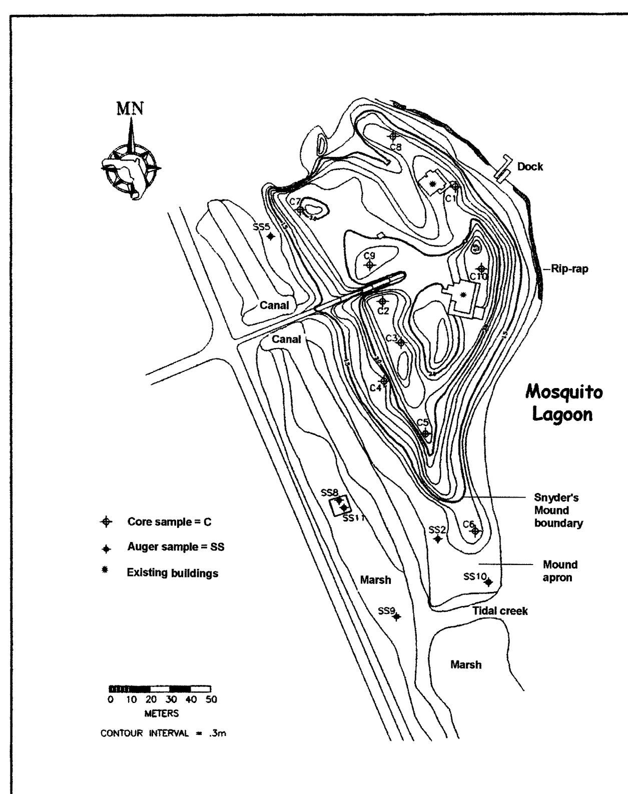

Fig. 2. Soil core and auger sample localities, Seminole Rest site.

3. Laboratory procedures

At the Florida Museum of Natural History (FLMNH), all samples were air dried, screened through 2 mm geologic sieves, assigned Museum catalogue numbers (FMSS no.) and subsampled for distribution to analytic labs. Selected samples of the <2 mm material were taken from deep core levels (mound substrate), marsh surface and peripheral mound areas, subsurface horizons beneath Fiddle Crab Mound, and off-site marsh areas.

Particle-size distribution of 50-g subsamples was determined using the pipette method [6] in the Environmental Pedology and Land Use laboratory, Soil and Water Science Department, University of Florida (UF). Samples with an estimated 1% or more organic carbon (judged by a dark brown or black color) were pretreated with hydrogen peroxide and heat to remove organic matter. The pH of a 2:1 water:soil solution was measured by glass electrode.

Samples for clay-size mineral identification were extracted from bulk soil samples by sieving through a 325-mesh geologic screen. Silts and clays were then separated by centrifugation. Clays were plated on to ceramic tiles and sets of two tiles from each provenience were saturated with either magnesium chloride and glycerol or potassium chloride. They were then X-rayed at room temperature (approximately 25 °C) and at 110 °C using a Nicolet diffractometer and Cu kα radiation at the Soil Mineralogy laboratory, University of Florida.

Fauna from each core and auger sample was identified. Invertebrates were identified to the lowest possible taxon using the modern systematic collections of the Environmental Archaeology Program and Malacology Divisions, FLMNH. Vertebrate faunal remains were small and fragmentary and were identified only to Class and noted as present or absent in each level. Presence or absence of charcoal was also noted. (Vertebrate remains and charcoal are not discussed in this study.)

4. Particle-size distribution analysis

Particle-size distributions of the <2 mm mineral component of Seminole Rest soils and sediments are presented in Table 1. The most abundant size class was fine sand (grain-size classes are defined in *Keys to Soil Taxonomy* [13]). With the exception of a small number of samples that contained either probable dredge spoil from canal construction or midden material, fine sand comprised from 52% to 77% of the sand-to-clay size fraction. Sub-mound core samples (from Snyder's Mound) and samples taken beneath and immediately adjacent to Fiddle Crab Mound contained more fine sand (mean of 70%) than soils from the area between those two features. In the higher-silt intermediate areas, mean fine sand content was 58%.

Medium sand was the second most abundant grain fraction. Sub-mound core samples and Fiddle Crab Mound zone samples contained the most, with a mean content of 18.5%. The high-silt sample on the southwest margin of Snyder's Mound had the least, with 11.4%.

Extremely high silt contents were encountered in all levels of the two samples taken between the western margin of Snyder's Mound and the modern canal (mean of 29% and 20%, respectively). In contrast, archaeological zone samples from Fiddle Crab Mound contained an average of 4.8% silt and sub-mound Snyder's core samples contained only 5.6 to 12.5% silt. The sample taken at the southern foot of Snyder's Mound had a high silt content in the upper levels that decreased to 3.8% at 90 cm below surface. Clay content in all samples was less than 1%.

5. Clay mineralogy

Table 2 presents a presence/absence summary of clay-size mineral occurrence per provenience. X-ray diffractograms of the clay species identified appear in Horvath et al. [8, Appendix 2.2]. Fig. 3 depicts smectite versus kaolinite/gibbsite distribution. In reporting the results of X-ray diffraction, the peaks resulting from magnesium/glycerol-saturated tiles X-rayed at room temperature will be discussed unless otherwise noted.

Clay mineral species from Seminole Rest occurred in two somewhat overlapping assemblages: (i) abundant smectite with small amounts of kaolinite and quartz, and (ii) low or minimal smectite with increased kaolinite and quartz and the appearance of hydroxy-interlayer vermiculite (HIM) and gibbsite. The latter grouping was found in the lower levels of the auger samples off the western margin of Snyder's Mound and west of the modern canal. It also appeared in three of four sub-mound core samples tested—those on the NW corner and on the seaward margin of the mound.

The sub-mound core and auger samples containing abundant smectite clays were located in the southern and west-central portions of Snyder's Mound. Clay from the upper-level auger samples in the vicinity of Fiddle Crab Mound also contained abundant smectite, plus kaolinite and quartz. The mineral assemblages in those localities changed with depth in a manner similar to those west of the canal. The smectite peak of the upper level was reduced to a minimum in the 90–100-cm samples, which contained HIM and gibbsite, and increased amounts of quartz and kaolinite.

6. Soil infauna

Faunal remains from Snyder's Mound core samples and excavation units were identified by zooarchaeologists at the FLMNH. Results of those examinations,

Table 1
Particle-size distribution analysis (wt.%), Seminole Rest archaeological site

Provenience	Depth, cm	FMSS no.	VC*	C	M	F	VF	Si	Cl
SS no. 8	25–35	1137	0.06	1.94	16.55	69.72	2.00	9.65	0.08
	45–55	1139	0.08	1.71	16.66	71.85	2.17	7.45	0.08
	55–65	1140	0.04	1.81	17.42	72.62	2.07	5.98	0.06
	65–75	1141	0.02	1.63	16.37	75.00	2.25	4.67	0.06
	95–105	1144	0.04	1.81	17.13	66.73	1.75	12.40	0.14
SS no. 11	35–45	1177	0.02	2.13	19.68	70.16	1.69	6.28	0.04
	55–65	1179	**						
	65–75	1180	0.04	1.73	17.18	70.60	1.87	8.38	0.20
SS no. 9	0–10	1149	0.60	2.35	14.47	74.53	1.51	6.46	0.08
	30–50	1153	0.01	1.38	14.46	68.38	2.23	13.32	0.22
	50–60	1154	0.02	1.68	15.40	66.84	2.03	13.79	0.24
	60–70	1155	0.02	1.99	16.75	61.56	1.74	17.74	0.20
	90–100	1158	0.06	1.39	15.45	69.52	1.93	11.51	0.14
Snyder Md									
Core 2	Level 10	1191	0.46	3.37	22.02	66.57	2.00	5.52	0.06
Core 5	Level 11	1192	0.82	6.95	19.22	63.79	2.12	7.04	0.06
Core 6	Level 5	1194	0.12	2.61	11.64	77.45	2.46	5.60	0.12
Core 7	Level 9	1195	0.16	3.10	17.02	71.73	1.71	6.24	0.04
Core 7	Level 10	1196	0.64	4.37	20.18	65.65	2.95	6.15	0.06
Core 10	Level 13	1198	0.14	2.43	21.03	63.86	1.41	10.91	0.22
Core 10	Level 14	1199	2.87	6.14	20.02	54.52	3.80	12.55	0.10
SS no. 2	10–20	1091	4.78	4.40	12.29	49.52	1.47	22.24	0.32
	20–30	1092							
	40–50	1094	0.12	1.55	11.57	55.43	1.69	29.26	0.38
	50–60	1095	0.18	1.52	10.55	52.00	1.58	33.71	0.46
	90–100	1097	0.08	1.82	11.94	59.64	1.86	24.28	0.38
SS no. 5	10–20	1115	2.09	4.00	16.59	51.73	1.57	23.84	0.18
	20–30	1116	0.42	3.11	17.31	61.49	1.59	15.88	0.20
	40–50	1118	0.16	2.06	15.90	62.46	1.64	17.50	0.28
	50–60	1119	0.18	1.97	15.12	56.95	1.69	23.83	0.26
	90–100	1123	0.10	2.08	19.05	70.30	2.00	6.37	0.10
SS no. 10	10–20	1163	1.83	7.45	25.02	48.60	3.03	14.05	0.02
	20–30	1164	10.00	10.53	18.08	34.96	4.35	21.76	0.32
	40–50	1166	0.80	3.94	14.46	67.81	2.09	10.72	0.18
	50–60	1167	0.22	3.63	15.87	71.42	2.06	6.68	0.12
	60–70	1168	0.14	3.79	16.83	72.04	2.00	5.10	0.10
	90–100	1171	0.20	4.40	18.71	71.08	1.73	3.80	0.08

*Abbreviations for particle-size classes, as follows: VC=very coarse sand, C=coarse sand, M=medium sand, F=fine sand, VF=very fine sand, Si=silt, Cl=clay.

**Not analysed.

which concentrated on midden materials, appear in Horvath et al. [8, Chs 4 and 5].

This study re-examined the upper core levels, comparing faunal taxa contained in them with those found in the sub-mound sediments and the auger samples. The focus was on the small invertebrate infauna that actually resided in the soils and sediments and not the larger species used as human food and deposited in the middens. An important indicator species proved to be *Parastarte triquetra*, Family Veneridae, the Brown Gem Clam, which was found only in the sub-mound sediments and not in the midden material that constituted the bulk of the Snyder's Mound.

Fig. 4 plots the relative abundance of *Parastarte* in cores and auger samples. The sub-mound sediments of three of four cores (C-9, C-3, and C-5) on the central western edge of Snyder's Mound contained few *Parastarte*. In contrast, about 25% of the total sample volume of the basal levels of the cores on the NW (C-7) and SW (C-6) corners of the mound was comprised of both articulated and disarticulated valves. Cores on the eastern half of the mound contained high numbers (>25% by volume) of clam shells. Core 8, in particular, contained many articulated valves of all size classes.

The auger samples were also examined for *Parastarte*. Samples taken west of Snyder's Mound contained none. A few waterworn valves were found in the uppermost level of the auger tests south of the mound. However, the two auger samples on the eastern margin of Snyder's

Table 2
Clay-size mineral occurrence

Provenience/Level (cm)	Smectite	HIM*	Kaolinite	Gibbsite	Quartz
SS no. 2/10–20	++	–	+	–	+
no. 2/90–100	++	–	+	–	+
SS no. 10/60–70	++	–	+	–	+
no. 10/90–100	++	–	+	+	+
SS no. 5/20–30	++	–	+	–	+
no. 5/90–100	++	+	+	–	+
SS no. 8/45–55	++	–	+	–	+
no. 8/95–105	(+)	+	+	+	+
SS no. 9/30–50	++	–	+	–	+
no. 9/60–70	++	–	+	–	+
no.9/90–100	(+)	+	+	+	+
Core 2 Level 10	+	+	+	+	+
Core 5 Level 11	(+)	+	+	+	+
Core 6 Level 5	(+)	+	+	+	+
Core 7 Level 9	(+)	+	+	(+)	+
Core 7 Level 10	(+)	+	+	(+)	+
Core 10 Level 13	(+)	(+)	+	(+)	+

Key: ++=abundant; (+)=minimal; –=absent.
*HIM=hydroxy-interlayer mineral.

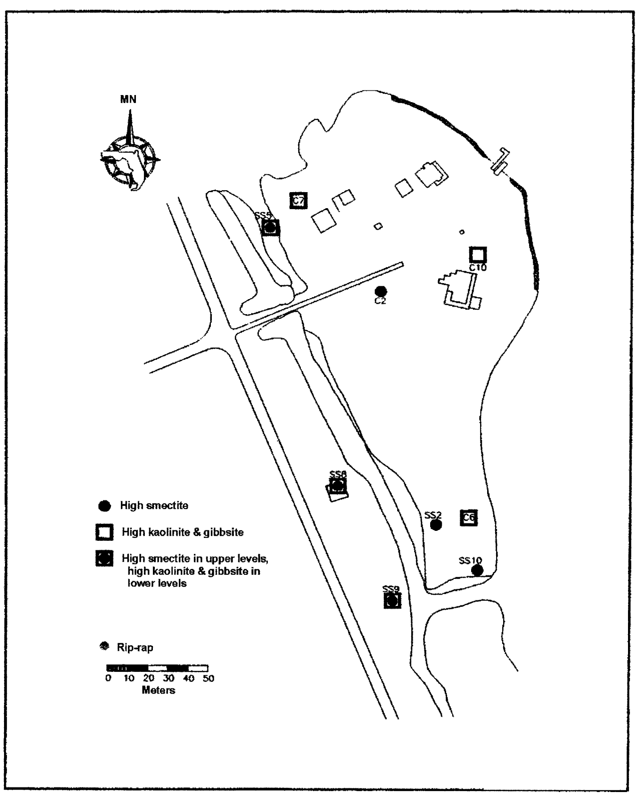

Fig. 3. Smectite and kaolinite clay distributions.

Mound (SS-3 and SS-6) had *Parastarte* throughout. Concentrations were highest in the upper levels, with abundant articulated valves of all size classes. Numbers diminished with depth in both samples.

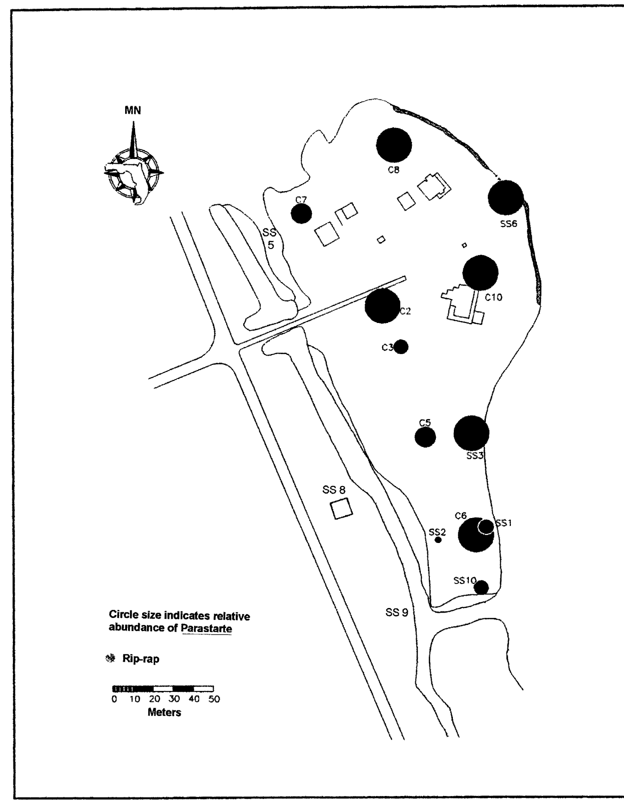

Fig. 4. *Parastarte* clam distributions.

7. Geophysical setting and local soils

The geology of the Mosquito Lagoon area, like that of most of the east coast of Florida, is characterized by sequences of sedimentary rocks, clays, and sands that chronicle a series of sea-level transgressions and regressions. Eocene limestones of the Avon Park Formation and Ocala Group are overlain by the Miocene Hawthorn Formation, consisting of interbedded carbonate and clastic clays and sands. Above this lie Pliocene and Pleistocene sands and shell marls and a mantle of Holocene sands [11] [14].

Mosquito Lagoon, which served as the major resource reservoir for the inhabitants of the Seminole Rest site, is protected from the Atlantic Ocean by a long, narrow barrier spit. The lagoon is approximately 33 miles long and articulates directly with the ocean only at Ponce Inlet. According to Mehta and Brooks [9] five inlets into the lagoon have opened and subsequently closed within the last 6000 to 7000 years. This has occurred in a south-to-north sequence, with the oldest inlet located near the southern attachment of the barrier spit to the mainland. The most recent inlet (previous to Ponce Inlet) was the 'Turtle Mound Inlet' which closed about 1500 years B.P. Since then, the lagoon has been accumulating fine sediments (silts and clays) and is now only about 4 feet deep. The southern end of Mosquito

Lagoon is believed to be a sediment-filled Pleistocene paleolagoon [2].

The Pleistocene beach ridges and terraces associated with the most recent sea-level changes affecting Florida's coasts are evident on the mainland landward of the Seminole Rest site. Soils associated with these physiographic features are predominantly oriented in coast-parallel groupings; their genesis reflects the mix of aeolian and marine parent material and dune ridge/swale topography that prevails [3]. The named soil south of Snyder's Mound is the Canaveral fine sand series, which forms on dune flanks and in interdune areas. The soil map unit encompassing the Seminole Rest site, the 'Turnbull Variant sand', is modern dredge spoil from the Intracoastal Waterway that traverses Mosquito Lagoon. This unit continues the shoreline defined by the Canaveral series to the south, and the sand that underlies it is undoubtedly Canaveral sand, dipping northward as a shallowly submerged sand bar. The relatively high coarse and medium sand contents and low silt contents in the basal core sediments beneath Snyder's Mound—compared with the peripheral samples—reflect a mixing of fine aeolian sands with coarser marine sediments, resulting in a texture characteristic of a low beach ridge or sand bar or bank.

North and west of the mound is the Turnbull muck soil series. This is a muck- or clay-over-sand series, the development of which has been accelerated by the closing of the 'Turtle Mound Inlet' and subsequent silting of the lagoon. The silty areas west and south of the mound may have been a low swale behind a bar, or a tidal creek, which gradually infilled with fine sediments after the closing of the inlet. The modern canals west of Snyder's Mound, superimposed over these silty areas, may be following previous natural landscape features.

8. Clay minerals

The identification of clay minerals in soils and sediments is critical to an understanding of paleoenvironments and archaeological sites [7] [12] because the stability of individual clay types varies in response to changes in soil characteristics. For example, smectite clays—the 'shrink/swell' clays—are stable in a high pH environment that is rich in calcium, magnesium, and silicon [5]. As silicon and cations are leached from the soil through weathering, smectite is transformed into either kaolinite or a hydroxy-interlayered mineral (HIM). Gibbsite [$Al(OH)_3$] contains no silicon at all, and is an end-product of clay transformations.

Due to these transformations, clay species assemblages are good indicators of the weathering status of soils, and of the history and condition of non-soil sediments [4]. 'Young' soils, or those that are either slightly weathered or receive constant or periodic input of primary sediments, are normally higher in smectite clays, which need more of the highly mobile and easily weathered soil elements for their own stability. A preponderance of kaolinite, hydroxy-interlayered clays, or weathering end-products such as gibbsite, indicate either an 'old' soil [10] or a body of pre-weathered sediments that may be transported by wind or water to become a component of a new soil or a submerged or aeolian sediment.

Although clay minerals were a minor component of the Seminole Rest samples, they support the particle-size findings that identified characteristics of a sand bar or bank beneath Snyder's Mound. Clay minerals in the sub-mound core samples have a relatively low smectite content and include abundant kaolinite, with some HIM and gibbsite. Again, these clays are commonly found in old, leached soils and also in marine sediments such as old dune, beach, or bar deposits which have been repeatedly chemically and physically reworked. Although the sub-mound environment is now enriched with calcium from the mountain of shell above it, and the pH is as high as (or higher than) the surrounding marsh, a remnant of the original mineralogy of the sediment is still preserved beneath the mound in the form of HIM and gibbsite.

Auger samples west of Snyder's mound and from the mound's southern tail contain an abundance of smectite, less kaolinite, and no HIM or gibbsite. The cation-enriched smectites are common in quiet-water lagoonal sediments that are high in soluble salts and have a neutral to high pH.

9. Invertebrate infauna

The composition of the invertebrate fauna of the sub-mound and peripheral sediments is another line of evidence supporting a sand feature beneath Snyder's Mound. Fig. 4 shows a high concentration of the Brown Gem Clam, *P. triquetra*, in six of ten of the sub-mound core samples and in four of the auger samples, particularly on the eastern margin of the mound. No *Parastarte* were found in samples to the west of the mound, with the exception of one individual, and none were found to the south.

Parastarte is a small (<3 mm) bivalve which inhabits, and is common in, sand bars [1]. The combination of high numbers of *Parastarte* and a low smectite, high HIV and gibbsite mineralogy in the sub-mound samples indicates a sand bar or other submerged sand body. In contrast, the high smectite environment lacking *Parastarte* west and south of the mound suggests a low swale area landward of such a sand feature.

The fact that *Parastarte* lives in inundated sediments argues that initial construction of Snyder's Mound began in a shallow-water area and not on dry ground. The high proportion of articulated shells and the representation of all size classes of this diminutive clam

indicate healthy populations of live clams in those sediments. The most reasonable scenario is of an existing near-shore *Parastarte*-inhabited sand-bar that was used as a convenient dump for clam shells emptied by aboriginal fisher/gatherers coming back to shore.

10. Conclusion

The question of whether the construction of Snyder's Mound began on dry land or whether debris was initially thrown into shallow water can be answered directly only by the clam evidence. Although the particle-size distributions and clay mineral identifications help to interpret the original environment and support the faunal results, they could each have similar characteristics in both terrestrial and shallowly submerged environments. But the presence of articulated clam valves, particularly of immature individuals of such a diminutive species, is strong evidence that they were in situ and alive when covered by midden debris. It is difficult to construct a scenario in which they could colonize sediments already covered by coarse midden materials. Considering their aquatic lifestyle, at least a minimal layer of water must have covered the site at the onset of midden accumulation.

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